Design, Testing and Development of a Camera Pig to Support the Cleanliness Assessment of Pipelines for CCUS.

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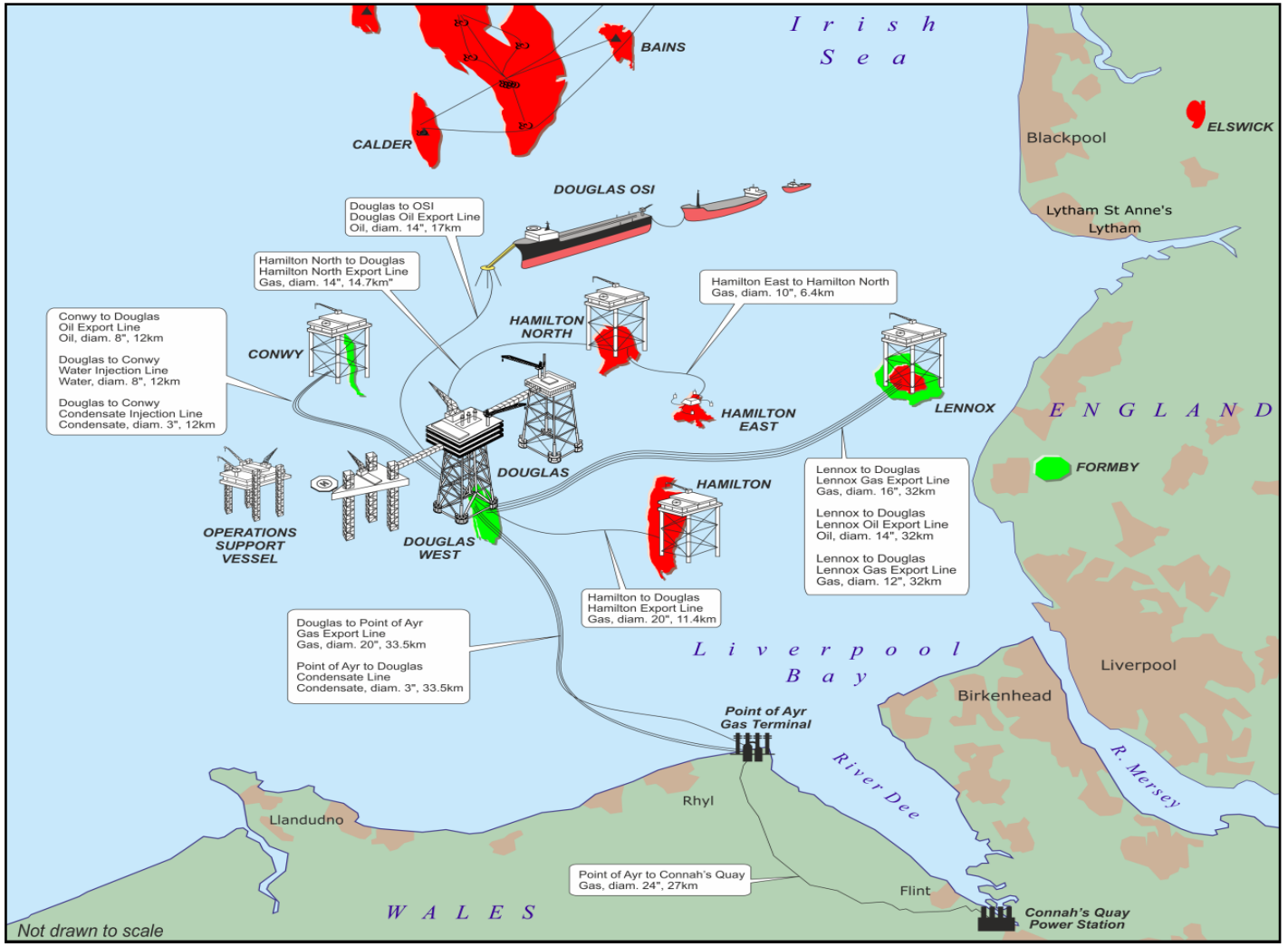
Background

- ENI's Liverpool Bay (LBA) region is located in the UKCS (East Irish Sea) and is made up of five oil and gas producing installations:
  - Douglas, Hamilton, Hamilton North, Lennox and Conwy.
  - Hydrocarbon production fluids are processed on Douglas, with oil sent to the OSI for storage/offload and gas sent to the PoA gas terminal.

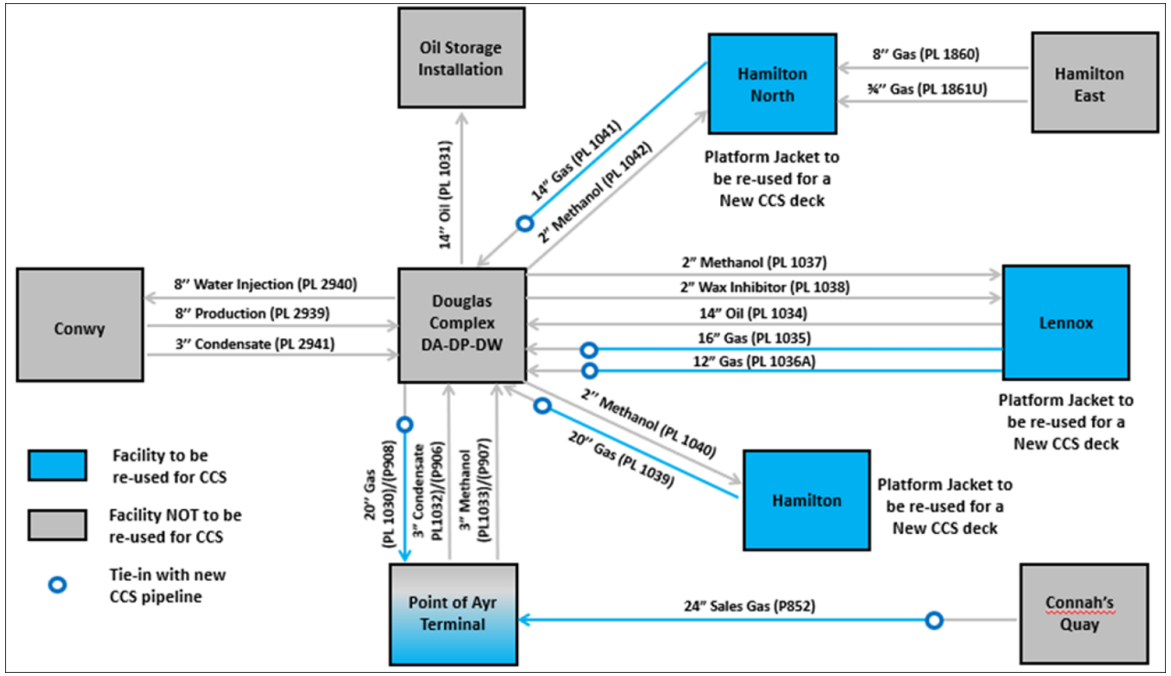


Background

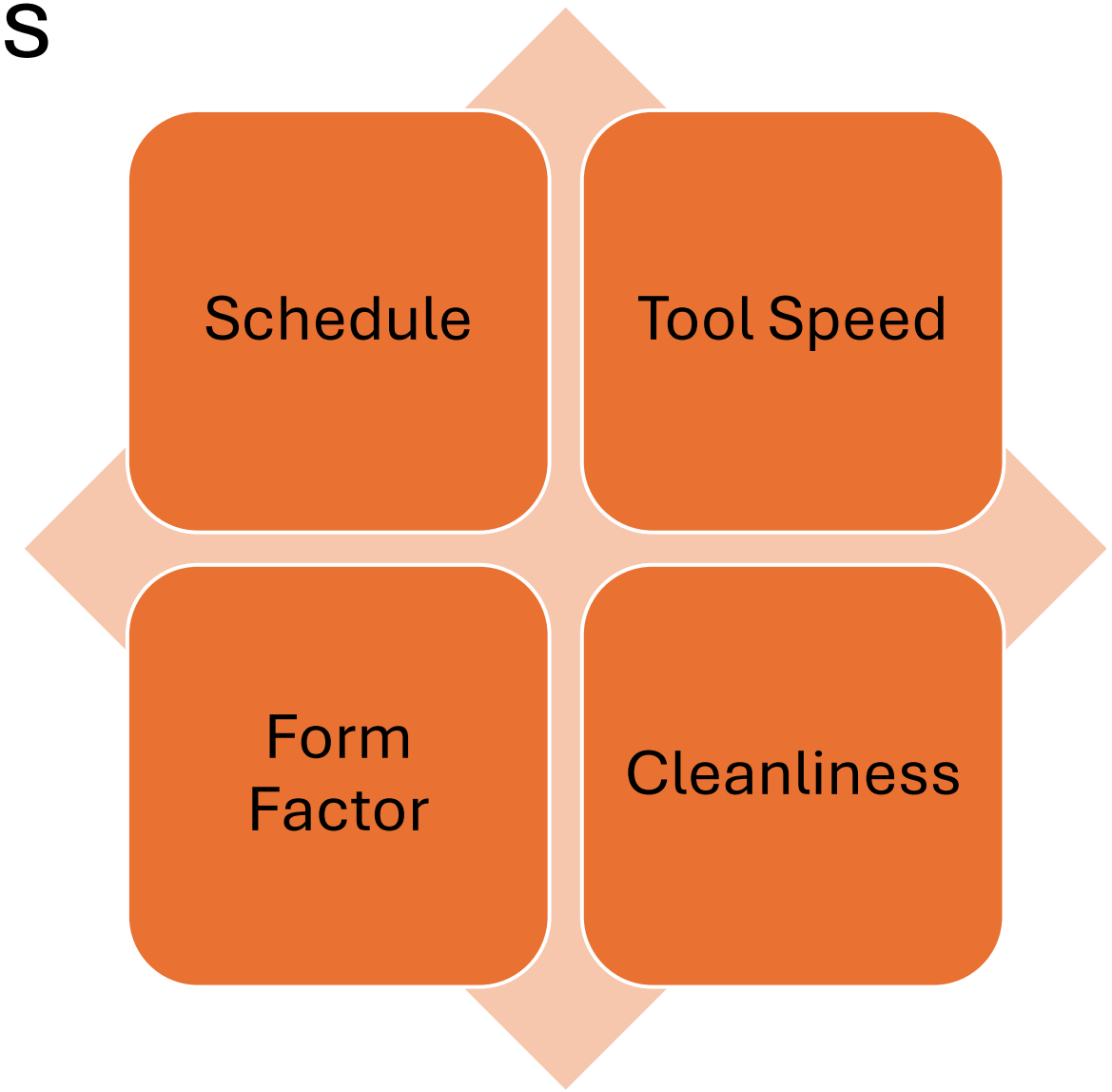
- Following the planned cessation of hydrocarbon production (late ‘24/early ‘25) the LBA region is to undergo a field decommissioning exercise, followed by a repurposing project which will see the LBA field being used for CCUS (Carbon Capture Utilisation and Storage) to support the wider UK Hynet project.
- A series of pipeline flushing and decommissioning activities are to be carried to support the project readiness.
- Pipeline cleanliness is paramount for the CCUS operation to be successful, therefore intensive pipeline cleaning is required.

Background

- Understanding the pipeline cleanliness quickly became identified as a challenging activity.
  - Opportunity to think differently due to repurposing.
- It was recognised that the most effective way to assess the pipeline internal surface would be via camera to visually record the extent of any debris.
- A visual assessment provides two key benefits:
  - Assess the level of cleanliness at the time of pigging.
  - Supports the requirements for the final pipeline cleaning prior to CCUS operation.
- Due to a gap in the pigging market EV were contacted by '*Baker Hughes Process & Pipeline Services Limited*'
  - The outlined premise to investigate options for a piggable camera, which could be used to visually record the internal surface of a pipeline to support the ENI repurposing activities.



Challenges



Solution
Schedule

- 6-week project development leadtime
- PigCAM® design based upon EV's downhole Optis® Infinity
- Long lead-time items sourced from existing downhole tools
- Utilised existing CADCAM programs
- Procurement, assembly, testing, optimisation

Fig a – existing downhole Optis®Infinity Array camera technology

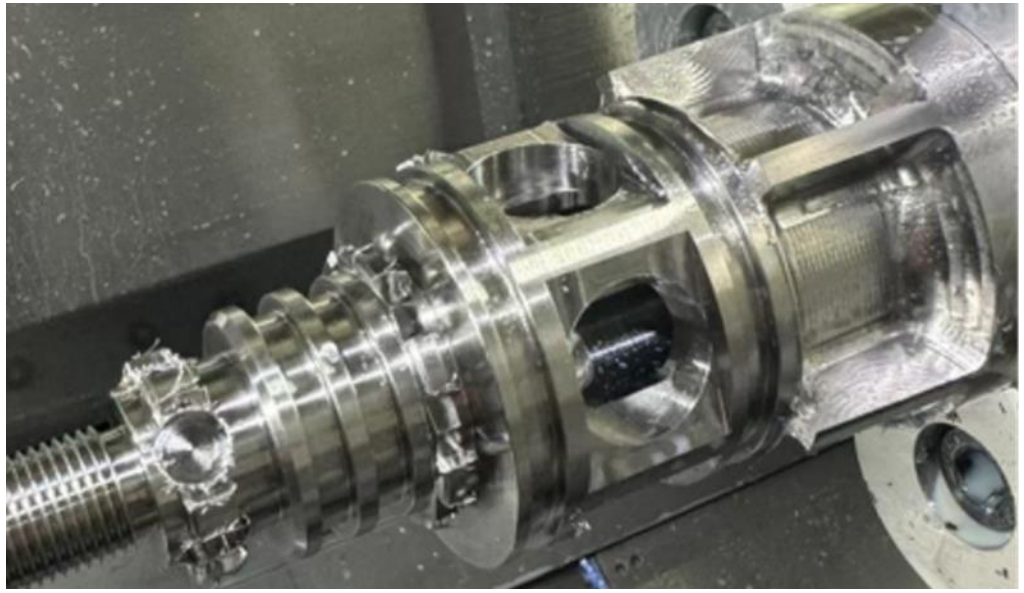


Fig b – New PigCAM® Array camera technology based upon existing EV technology

Solution
Form Factor

Downhole Optis®Infinity framework

- 43mm Body OD (1 11/16”)
- 4000mm Total Tool Length
- 800mm Tool Sections
- No Articulation

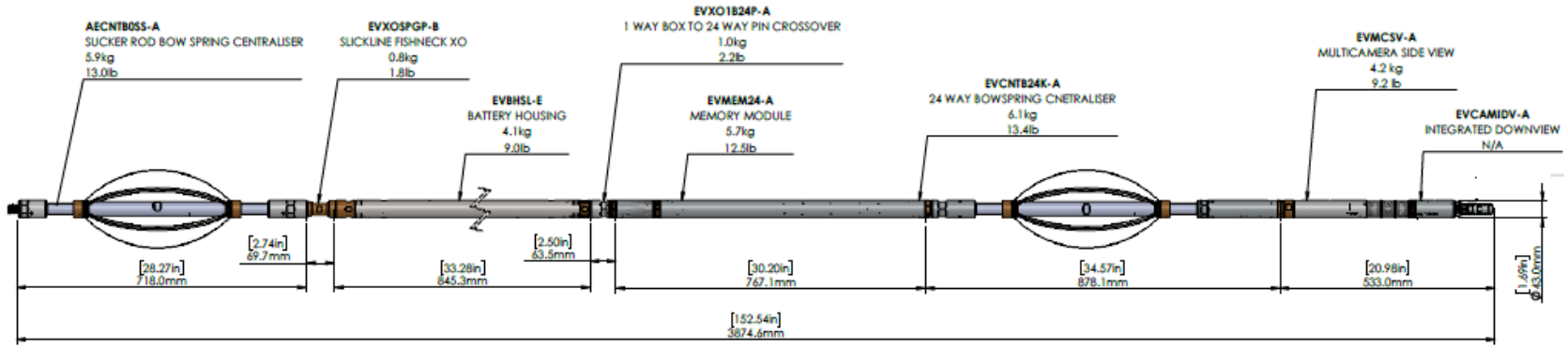


Fig e – Downhole Optis®Infinity downhole array camera

New PigCAM® Pipeline technology

- 114.3mm OD (4 ½”)
- 1900mm Total Tool Length
- 500mm Tool Sections
- Articulated Joints

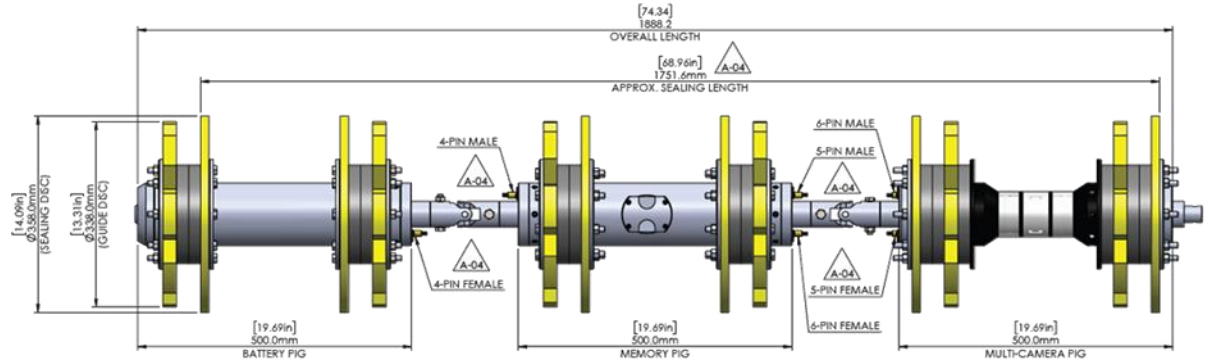


Fig f – Pipeline PigCAM® array camera, new technology

Solution
Tool Speed

- Tested Optis® Infinity in EVs Test Pipe with linear actuator
- Benign conditions
- Distance to side wall would be greater

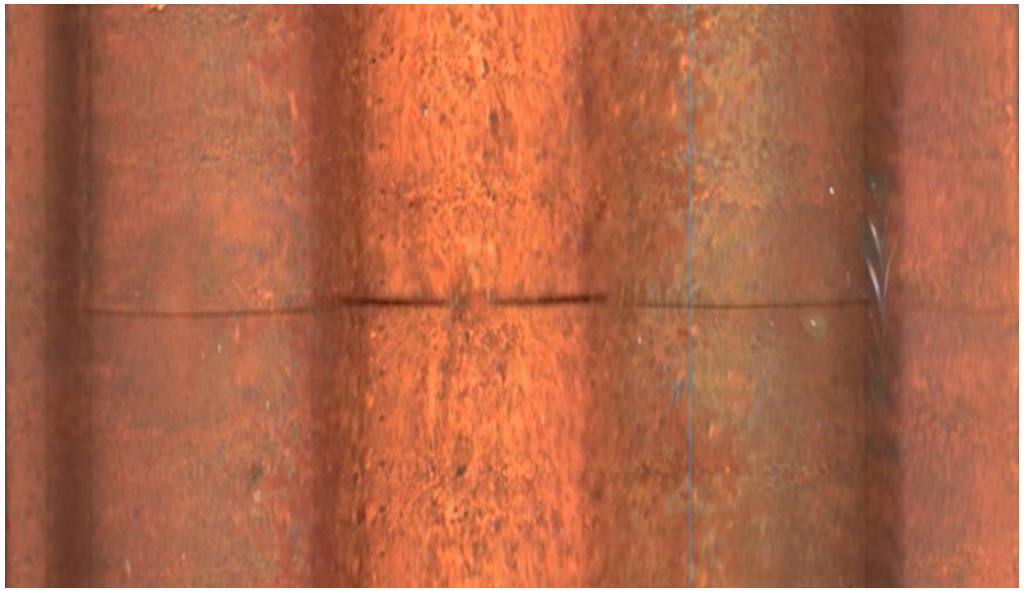


Fig c – test run at 49ft/min (0.25m/s)

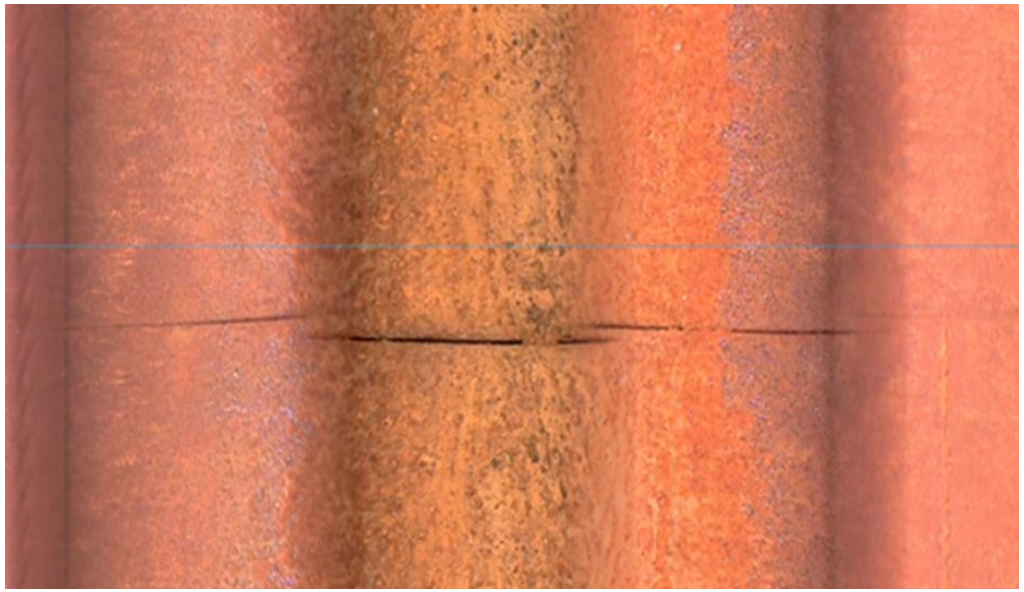
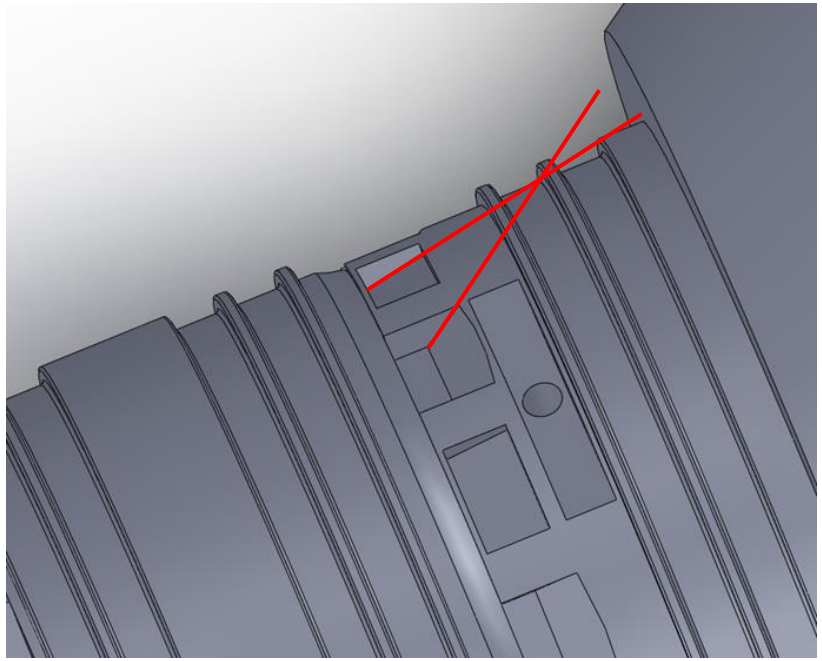
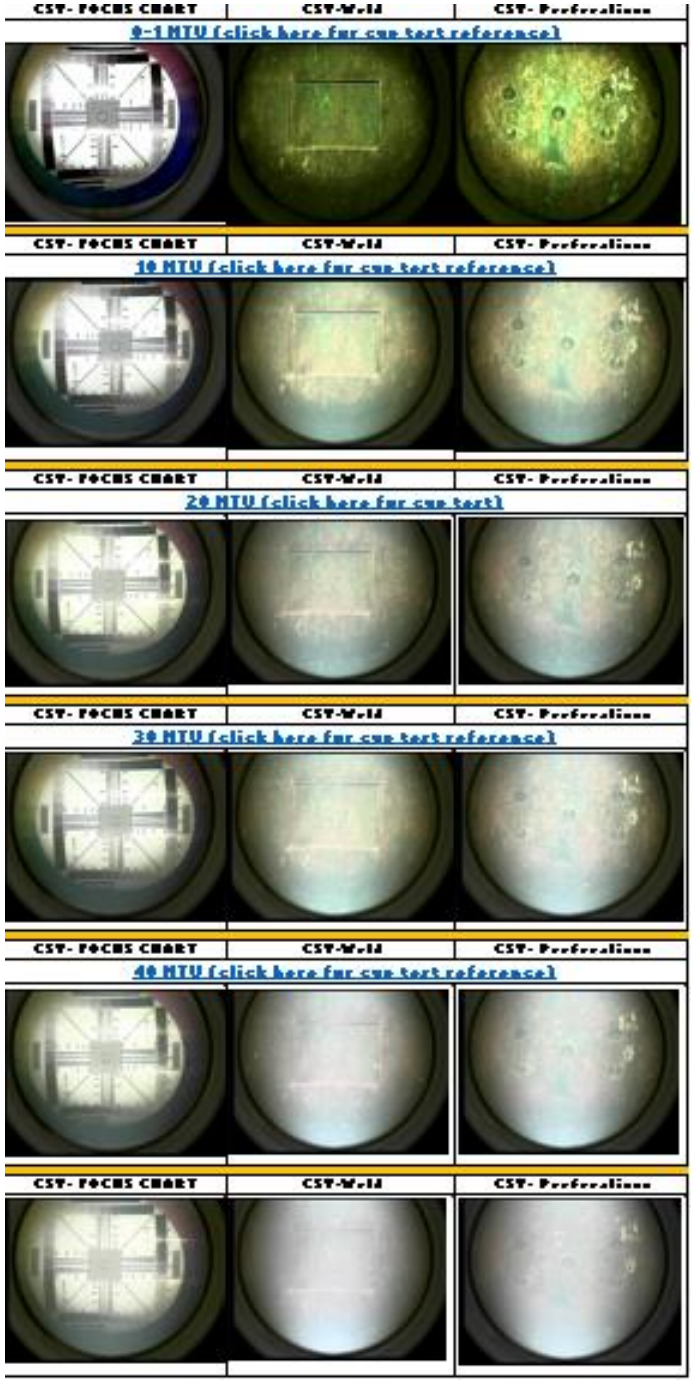


Fig d – test run at 98ft/min (0.5m/s)

Solution
Cleanliness

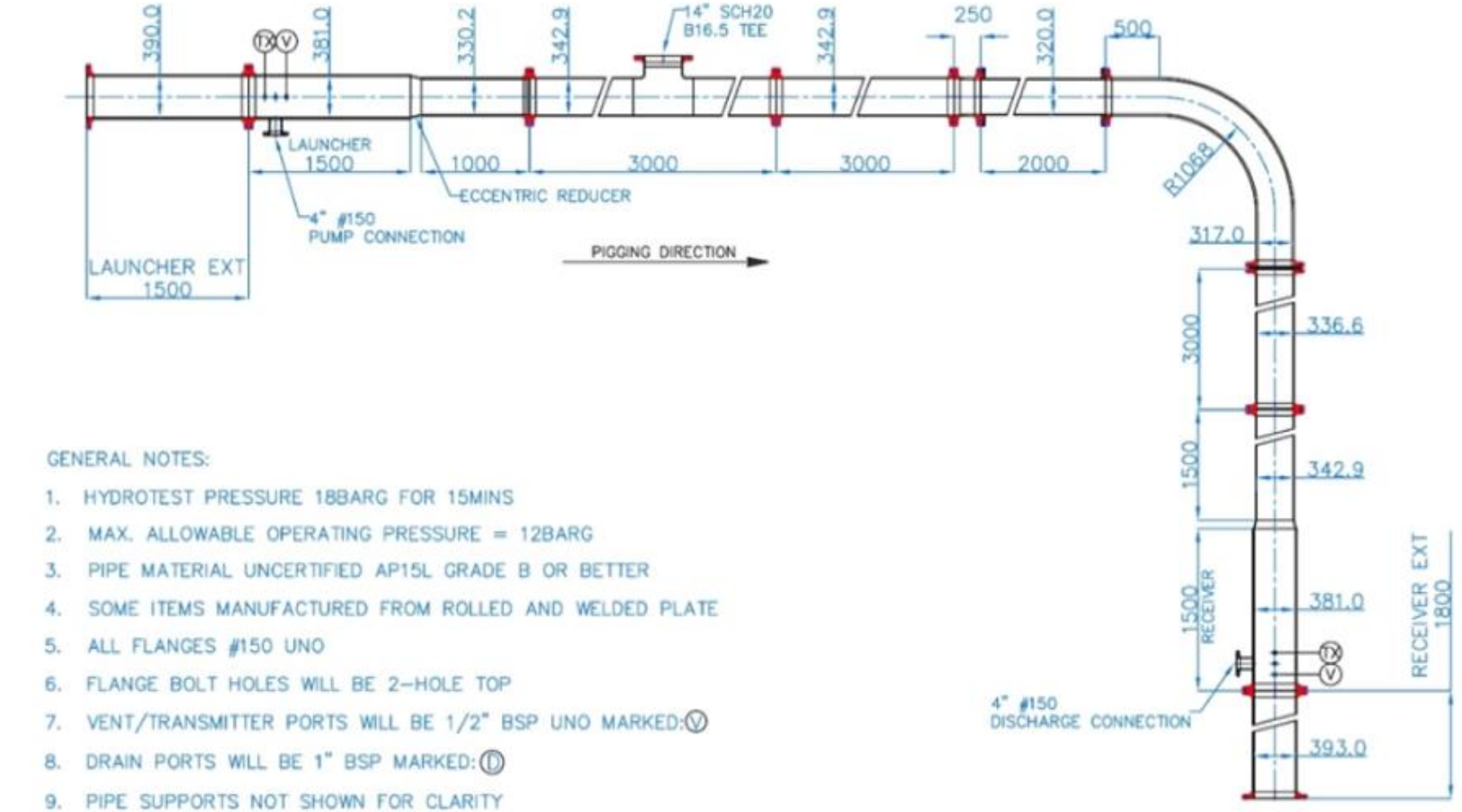
- Light optimisation
- Surfactants/Surface treatments
- Operational procedure
- Parameters for success/fail





Testing Objectives

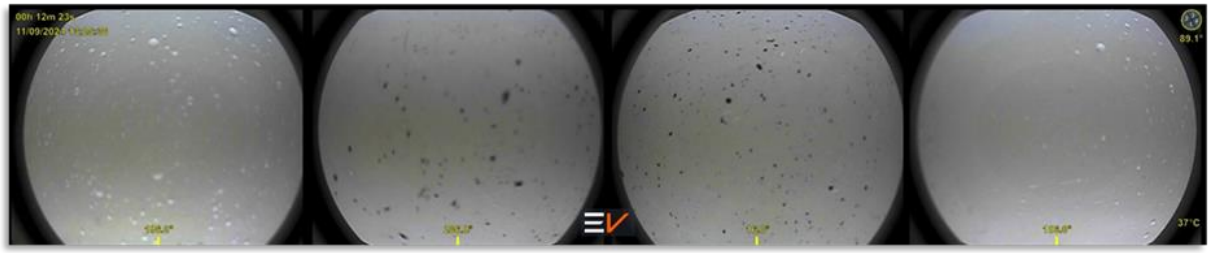
- Prove Piggability
- Camera position
- Light Level
- Speed of Travel
- Camera Settings



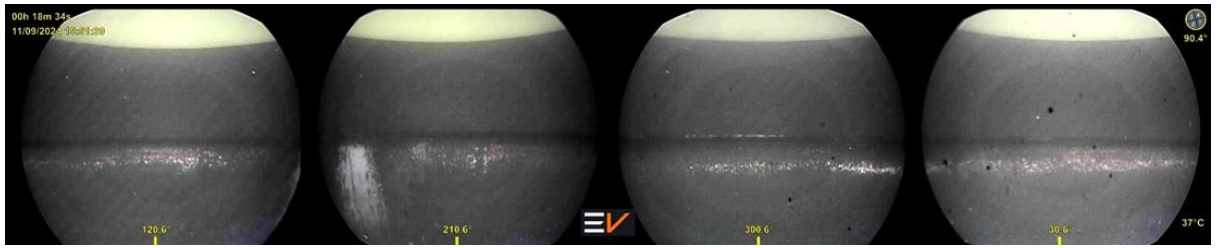
GENERAL NOTES:

1. HYDROTEST PRESSURE 18BARG FOR 15MINS
2. MAX. ALLOWABLE OPERATING PRESSURE = 12BARG
3. PIPE MATERIAL UNCERTIFIED AP15L GRADE B OR BETTER
4. SOME ITEMS MANUFACTURED FROM ROLLED AND WELDED PLATE
5. ALL FLANGES #150 UNO
6. FLANGE BOLT HOLES WILL BE 2-HOLE TOP
7. VENT/TRANSMITTER PORTS WILL BE 1/2" BSP UNO MARKED:Ⓥ
8. DRAIN PORTS WILL BE 1" BSP MARKED:Ⓓ
9. PIPE SUPPORTS NOT SHOWN FOR CLARITY
10. ALL TRANSITIONS 1:4 OR GREATER

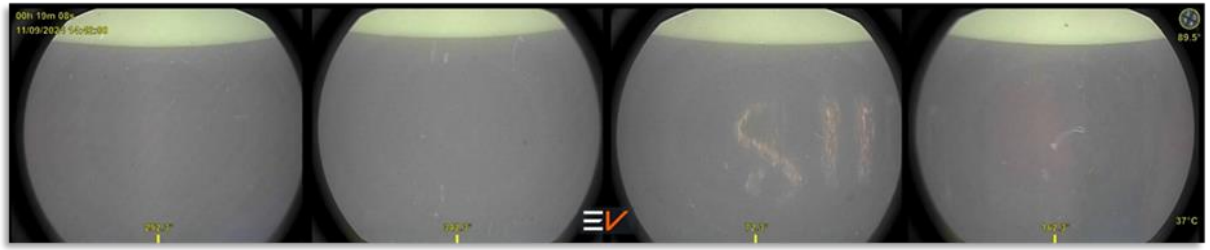
Testing
Results



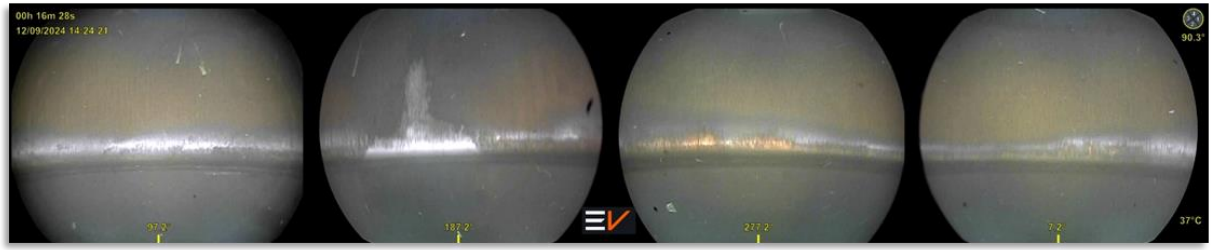
Camera at front, 0.17m/s



Camera at rear, 0.17m/s, increased contrast

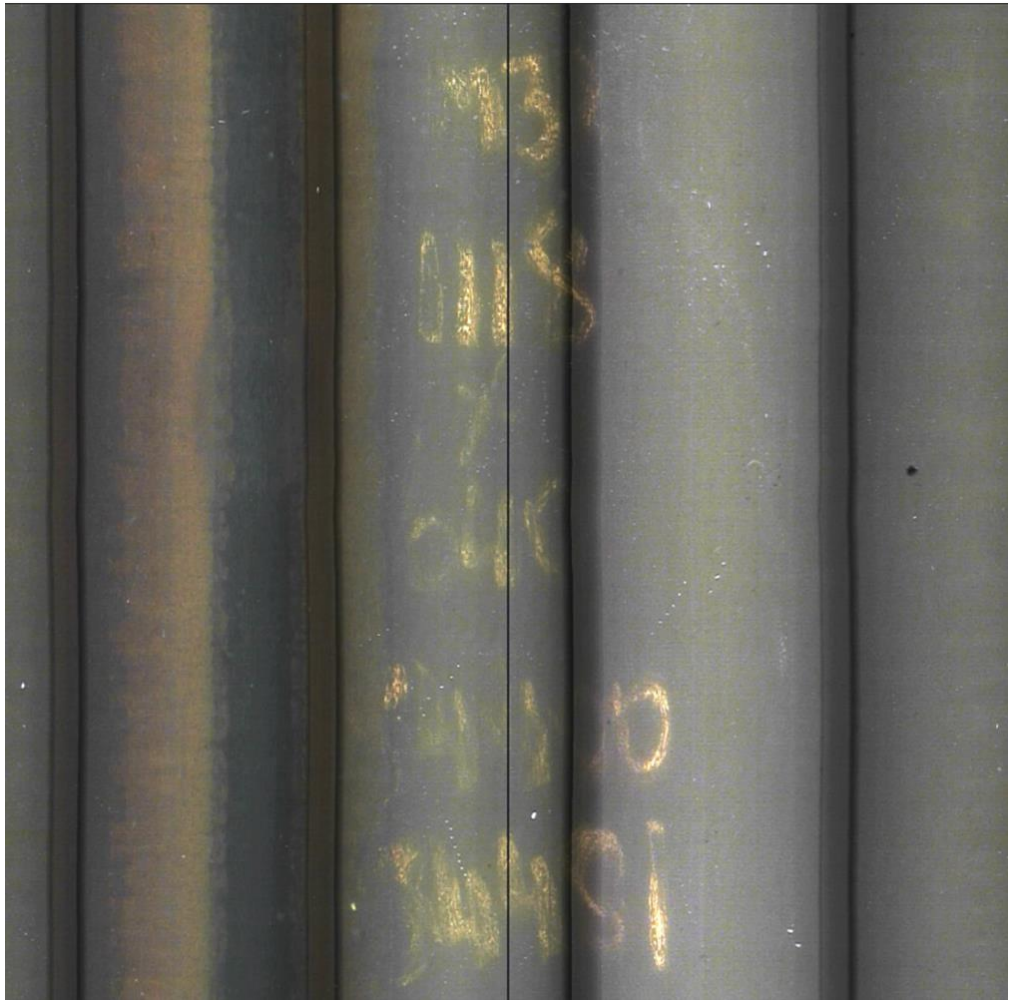


Camera at rear, 0.17m/s

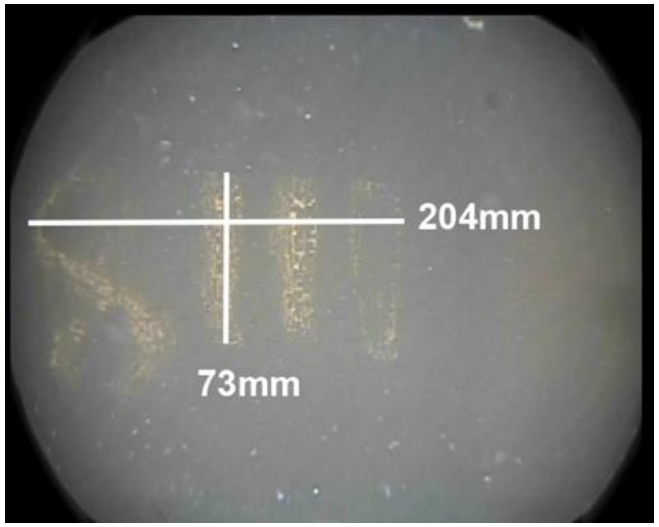


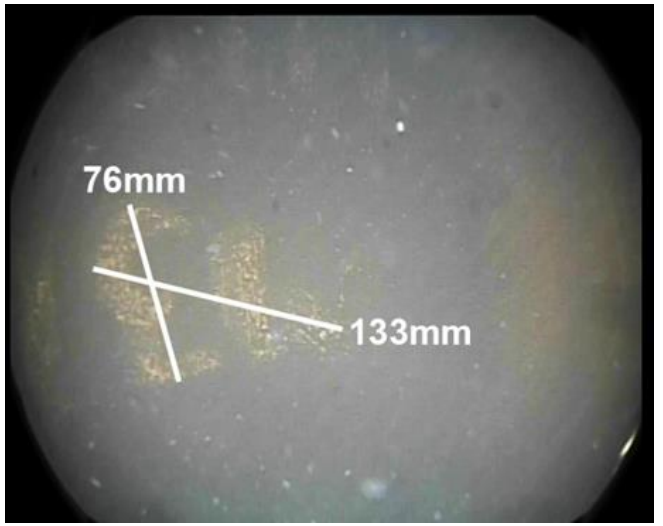
Camera at rear, 0.20m/s, camera hardware modifications

Testing
Deliverables



Known ID, camera position, optical design allows dimensioning using EVs proprietary dimensioning software





- Quality of Data enabled the images to be stitched using EVs Stitching Software
- Improved image clarity
- Localised image enhancement
- Reduced interference and obstruction from particulate

Conclusion and Thanks

- Pig traversed pipeline without any issues
- Camera performed flawlessly and was optimal at train rear
- Settings improvements made on site improved results significantly
- Maximum light level, with all lights illuminated, proved best
- 0.17m/s – 0.2m/s caused no issues
- Product ready for deployment
- Various pig sizes available to suit different Pipeline diameters

- Thank you to EV Offshore, Baker Hughes Process and Pipeline Services Limited and to ENI for supporting this paper release.

Baker Hughes

eni eni uk

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